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ABSTRACT

In Skinner's analysis of verbal behavior, three categories of environmental control over instances of verbal behavior appear to be relevant to the study of infant vocal development: the mand, the tact, and the echoic categories. Procedures used in the remediation of language deficiencies and procedures found in work in the area of language learning and communication may also be relevant to the functional analysis of the acquisition of vocal behavior by infants. Topographically, infant vocal development progresses from diverse and indiscriminant vocal behavior to differentiated and discriminated vocal/verbal skills during the first year of life. One valid operant explanation of the functional development of infant vocal behavior is that the infant's differential responding to the vocal environment she/he is experiencing is consequated with homeostatic reinforcers which are in turn paired with social consequences parents typically provide. As a result of experiencing this pairing process intensively, the tactile, visual, and auditory stimulation provided by the parents take on discriminative as well as reinforcing properties for the infants. Once established and maintained as a discriminative and reinforcing stimuli, these adult behaviors could function to set the occasion for and consequate approximations to adult behavior by the infants. This explanation would account for the manding, echoic, and tacting functions that appear to be characteristic of much of the first year of the infant's vocal behavior. (JMB)

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INFANT VOCAL DEVELOPMENT

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VERBAL BEHAVIOR, LANGUAGE REMEDIATION, LANGUAGE LEARNING, AND COMMUNICATION

Skinner's analysis of verbal behavior (1957) deals with the identification of the environmental variables that control fully developed adult verbalizations. In his analysis he has classified verbal behavior in terms of the kinds of environmental control exerted over instances of verbal behavior rather than solely in terms of topographic distinctions. Of the various classifications that he proposes, the "mand," "tact," and "echoic" categories appear most relevant to the study of the development of infant vocal behavior during the first year of life.

It is common for an infant's caregivers to consequate various of the infant's vocalizations with what they infer the infant is "requesting." For example, fussiness may regularly be consequated with food, a diaper change, or being put to bed depending on the form the fussiness takes and the situational cues to the caregiver. Other vocal behavior may regularly bring some form of adult social and physical attention to the infant, after all who among us can easily resist vocal play with a responsive infant? As a result it is conceivable that certain functional classes of vocalizations are differentiated because they come to be controlled by certain characteristic classes of consequences delivered by the caregivers. This kind of outcome matches quite closely Skinner's (1957) definition of the "mand."

In a similar fashion caregivers also tend to reinforce infant vocal behavior that seems correlated with specific parts of the infant's environment. This becomes particularly evident after the onset of what is often called babbling. Parents are particularly fond of attributing the ability to identify "mama" and "dada" to their infant on the basis of what a disinterested observer may call diffuse babbling. As a result of such reinforcement it is conceivable that infants learn to "tact" (Skinner, 1957) the world.

It would be naive, however, to presume that the kind of shaping implied by this analysis can validly account for the development of all

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or even most adult-like verbal behavior. Thus, the observation that infants come to imitate some of the sounds they hear (Gardner & Gardner, 1970, McCarthey, 1954) becomes relevant to the description of infant vocal development. Skinner (1957) has labeled such behavior as "echoic" for obvious descriptive reasons. It is the goal of this paper to discuss the relevance of this analysis and the work done in the areas of language remediation, language learning, and communication to the evidence available from investigations into infant vocal development.

Much of the work done in the area of language remediation has employed prompting and differential reinforcement procedures (see Guess, Sailor, and Baer, 1976) in attempts to produce, shape, and/or maintain adult-like verbal behavior by individuals with incomplete and/or inappropriate verbal skills. The prompts used most often take the form of models of the correct verbalization (see Sherman, 1971). When observing adults interact with infants it is quite common to hear them provide models of adult speech as well as imitate and model vocalizations that they have heard the infant emit. Thus, the procedures found to be functional in the remediation of language deficiencies may be relevant to the functional analysis of the acquisition of vocal behavior by infants.

The work done in the area of language learning and communication has also concentrated on the effectiveness of modeling procedures with and without specific reinforcement procedures (Whitehurst, 1973). The informational value of the topography of models is being investigated as well (Sonnenschein, Whitehurst, and Marcantel, 1978). These modeling effects are relevant to infant vocal development in the manner that has been previously described. In addition, it is interesting that, when asked to increase their infant's emission of a particular vocalization, parents use a modeling procedure almost exclusively (Hursh and Sherman, 1973).

Given the analyses and/or evidence from the areas of "verbal behavior," "language remediation," as well as "language learning and communication" it seems reasonable to review the available data on infant vocal development to determine what functional and/or topographical similarities may exist among these various research literatures. By doing so it may be possible to determine an empirically supportable theory of vocal/verbal development that integrates the present evidence and points the way for future investigations that can extend a functional analysis to increasingly more complex aspects of the behavior humans use to communicate with one another.

INFANT VOCAL BEHAVIOR

There exists an abundance of data that provides a description of the topographies of infant vocal behavior (Bloom, 1975, McCarthy, 1954). This evidence indicates that most normal infants' vocal behavior progresses from undifferentiated crying and grunting in the first month of life to babbling and cooing beginning roughly during the second month. By the third month infants begin to emit two syllable utterances that continue as does babbling in general throughout the first year of life. Imitation of simple sounds is observed beginning at about six months of age when the infant's articulation has become well defined. Imitation of sounds is common by the ninth month and by the eleventh month an infant will also imitate syllables. Generally, the infant's first words are emitted during the eleventh or twelfth month and imitation of these words occurs concurrently. Clearly, from a purely descriptive standpoint, infant vocal development traverses quite a distance toward the rudiments of language during the first year of life. A more fine-grained phonetic analysis of this vocal development supports the same conclusion (McCarthy, 1954).

Given the progression from diverse and indiscriminate vocal behavior to differentiated and discriminated vocal/verbal skills that appears to describe most normal infants' vocal development during their first year of life, it seems only reasonable that one ask the experimental question, "What is this change in behavior a function of?" Fortunately a number of investigators have asked that question and have attempted to answer it in a variety of ways. The remainder of this paper will be concerned with summarizing these data, drawing any conclusions that may be warranted, and proposing areas of further investigation that appear to be important to a functional analysis of infant vocal development.

A FUNCTIONAL ANALYSIS

It seems reasonable that any human behavior must be a function of an interaction between evolutionary and everyday environmental influences. After all evolutionary influences are merely the result of the effects of the environment on the development of the species evidenced by the individual's genetic and structural characteristics at the time of his/her birth. From birth on the individual's behavior is a function of these phylogenetic influences and their interaction with the person's experiences

in his/her everyday environment. Thus, phylogeny and ontogeny are both products of environmental influences. However, in the case of language, and most other complex human behavior that has developed since the advent of civilization, the primary focus of a fuctional analysis should be on the everyday environmental influences once the genetic and structural characteristics of the organism have been determined. This appears to be a reasonable position to take since the time and generations required for most evolutionary influences to be evidenced in the behavior of the species is much greater than the time and generations it has taken to develop human verbal behavior.

Now to the summary of the evidence relevant to the development of human verbal behavior during the period of infancy. In a recent review, Eimas and Tartter (in press) have described experimental evidence suggesting that human infants are born with the necessary mechanisms for discriminating very fine phonetic distinctions that are both a part of and not apart of the language community into which they are born. However, for some of these phonetic distinctions the data suggest that experience may be a necessary precondition for successful discrimination. Thus, human infants are born with the equipment to be responsive to some of their vocal environment but require experience with that environment before they are able to fuction fully in response to the complexities of it.

One possible indication that an infant is responsive to his/her environment is the observation of imitative behavior. At least one study reported in the literature (Gardner and Gardner, 1970) describes "selective" imitation of motor behavior as early as six weeks of age. The same study also reports "selective" vocal imitation at 10 weeks by the same infant. The term "selective" is used here to describe the kind of imitative behavior that is under the control of the form or function of the model's behavior in contrast to "direct" imitation wherein the imitative behavior bears a one-to-one topographic correspondence to the model's behavior. Whitehurst and Vasta (1975) have reviewed the evidence for and against the position that imitation plays a major role in language acquisition. On the basis of the results of operant, social learning, and other studies of language, they conclude that a "comprehension-imitation-production" sequence (wherein the imitation is "selective") can accurately describe the acquisition of language in human children. The empirical questions they leave us with involve

determining the means by which this sequence is brought about in the everyday environment. That is, what are the variables in the human infant's environment that are functionally related to the infant's acquisition of the skills necessary to comprehend then imitate his/her vocal environment and ultimately produce vocal/verbal behavior "spontaneously" yet "discriminately?"

The data mentioned previously, demonstrating infants' innate abilities to make relatively fine discriminations of adult-like phonetic distinctions and their increasing discriminative skills as a result of experience, would support the notion that comprehension comes first. At least two other studies (Webster, 1969, Webster, Steinhardt, and Senter, 1972) have presented data indicating a systenatic reduction of infant vocal behavior during the presence of adult-like sounds they are presented with. Preliminary results of an investigation the author (Hursh, in progress) is conducting are replicating this "listening" phenomenon with direct parental vocal imitation of their infants' Vocal behavior. The viability of these results in helping to explain vocal development depends on the degree to which parents do in fact interact with their infants vocally in their everyday environment. In a study of mothers' verbal interactions with their infants at one, three, and eight months of age (Cohen and Beckwith, 1976) it was found that the mothers were variable in the amount and style of their language input. However, a particular mother would have the general aspects of her input highly correlated within and across the various ages of her infant. The specific content of the mothers' language input. however, did change with changes in age of the infant. Thus, it appears mothers do tend to adopt a particular style of language input to their infants but are responsive to changes in their infants' behavior as the infant develops.

If the data presented thus far are reliable, there appears to be evidence for the notion that infants do learn to comprehend their vocal/verbal environment and respond to it in an imitative as well as productive manner. A functional analysis of this vocal/verbal behavior requires a demonstration of the variables that control such a systematic set of data. The operant perspective would suggest looking for the way in which environmental consequences may be operating to shape discriminative skills that lead to the effectiveness of models and ultimately maintain the "spontaneous" production of vocal/verbal behavior.

Although there is a strong indication in the infant vocal conditioning literature (e.g., Rheingold, Gewirtz, and Ross, 1959; Routh, 1969; Sheppard, 1969; Weisberg, 1961) that consequences can control infant vocal responding, at least two exceptions remain to be explained experimentally (Bloom, 1975, Bloom and Esposito, 1975). The exceptions demonstrated the equal or greater effectiveness of response independent as compared to response dependent stimulation. Other studies have also indicated the delayed effectiveness of response independent stimulation (Dodd, 1972) and the fact that parents, when asked to get their infant to produce a particular vocalization, rely almost exclusively on modeling, providing no consequences for the infant's production of the target vocalization (Hursh and Sherman, 1973). Thus, the straight forward notion that the adult verbal community directly shapes the vocal/verbal development of its infants does not appear tenable. However, this does not rule out a valid operant explanation of the data. One such explanation that may bear experimental analysis follows.

A CONCEPTUAL ANALYSIS

Phylogenetically infants arrive in this world with the equipment to respond differentially to environmental stimulation of the audio, visual, tactual, olfactory, and gustatory kinds (see Reese and Lipsitt, 1970). The data support this contention descriptively and the survival requirements during the evolution of the species help to explain these human characteristics from a functional perspective. The infant's differential responding to the vocal environment he/she is experiencing is consequated with homeostatic reinforcers such as nourishment, warmth, and relief from discomfort. Paired with these homeostatic reinforcers are the social consequences parents typically provide, such as tactile, visual, and auditory stimulation. As a result of experiencing this pairing process intensively during their waking hours, the tactile, visual, and auditory stimulation involved takes on discriminative as well as reinforcing properties for the infants. Once established and maintained as discriminative and reinforcing stimuli, these adult behaviors could function to set the occasion for and consequate approximations to adult behavior by the infants.

In the area of infant vocal development this explanation would account for the "manding," "echoic," and "tacting" functions that appear to be characteristic of much of the vocal behavior that develops in the first year of any normal infant's life (McCarthy, 1954). From the author's observations of himself and others interacting with infants it is obvious that

adults do use tactile, visual, and auditory stimulation in such situations. What remains to be done is the long slow process of experimentally investigating the function of these stimuli in relation to the infant's vocal development. This is precisely what the author is currently engaged in, beginning with the effects of parental vocal imitating of their infant in an attempt to replicate and extend the work begun by Haugan and McIntire (1972) to an analysis of parental imitation effects on the topography of their infants' vocal behavior (Hursh, in progress).

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